

CHP Project Profiles in Multifamily Housing

COMBINED HEAT AND POWER (CHP) systems are onsite energy systems that make both electricity and usable heat for buildings. This heat, recovered from the power generator, often can heat, cool, or dehumidify building space for much greater energy efficiency and lower cost than conventional systems. Multifamily housing may be ideal for CHP by using packaged systems for commercial-scaled projects, or by realizing economies-of-scale by using industrial or district energy-scaled equipment to meet demand from larger projects.

The U.S. Department of Housing and Urban Development (HUD) has established an Energy Action Plan to promote the President's National Energy Policy. One action is to further CHP in public housing and privately owned assisted housing, as well as in the redevelopment of brownfields. As part of that effort, HUD and the U.S. Department of Energy (DOE) are developing the CHP Project Profiles in Multifamily Housing series. Through straightforward assessments of CHP projects in public and assisted housing, these profiles are designed to encourage increased use of CHP in other HUD housing projects.

Wooster Manor: City of Danbury Public Housing Authority | Danbury, CT

PROJECT HISTORY

Wooster Manor is a seven-story, 100-unit, multifamily residential building operated by the City of Danbury, Connecticut, Public Housing Authority (DHA). Before project implementation, Wooster Manor was an all-electric building featuring electric resistance baseboard heating and oversized central electric water heaters for hot water supply. In 1998, the DHA converted units on four floors to hydronic baseboard heating, removed the electric water heaters, and installed a 60-kW packaged CHP system to provide electricity and hot water to the building. With these changes, the building's energy costs dropped by almost 50%.

To design and implement the project, DHA Modernization Coordinator David Ghio worked closely with Richard Hughes, Account Executive for Yankee Gas Services Company, and with CHP project developer Aegis Energy Service (West Springfield, MA). Using the CHP feasibility study that Aegis prepared, Ghio was able to demonstrate that CHP was an economically attractive investment. "With energy consumption and costs very high," notes Hughes, "Wooster Manor really stood out as a place that could greatly benefit from technology and alternative

energy options that would improve efficiencies and costs for the Housing Authority and comfort for its tenants."

CHP SYSTEM DESCRIPTION AND ANALYSIS

The Tecogen packaged cogeneration unit now serving Wooster Manor features a 454-cubic-inch displacement natural gas-fired engine that turns a generator supplying 60 kW of electricity. The main supply panels in the building receive the cogenerated electricity, which is then distributed to meet approximately 60-70% of the total building load. Electricity from the grid serves the remaining load.

The unit is interconnected to the local electric distribution grid and the facility relies on the local electric utility for emergency backup. Three back-up boilers that run on natural gas serve as standby units. These boilers supply hot water to the heating and domestic hot water systems at peak demand periods or when the system is not operating. Yankee Gas ran a service line from the nearby gas main to the facility to serve the Tecogen unit and the backup boilers. The company was able to do this at no cost to the DHA by using a bundled general services rate.

PROJECT AT A GLANCE

"This project has provided an excellent model to apply to other facilities."

David Ghio, *Modernization Coordinator, DHA*

Unique Characteristic:

Project completed at no up-front cost to the Housing Authority

CHP System:

One 60-kW Tecogen engine-driven packaged CHP unit

Thermal Uses:

Hydronic space heating for dwelling units on four of seven residential floors; all domestic hot water

Lesson Learned:

Motivated project partners are a key to success



To house the system, the DHA enclosed an existing building overhang. The vent stack for the system extends 10 feet beyond the roofline to meet code requirements relating to proximity of vent stacks to residences.

Use of Recovered Heat

Heat contained in the Tecogen unit's engine jacket and engine exhaust is captured in the heat recovery module and used to heat the engine water to 215°F. The hot water is distributed to dwelling unit baseboards for space heating and through the domestic hot water piping throughout the building. The CHP system meets 50% of the building's total space heating needs and 100% of domestic hot water needs.

In summer, when space heating is not needed and the hot water load is somewhat lower, excess heat from the engine is dispersed through a radiator to the outside. A large fan coil unit keeps the engine cool, similar to how a car engine is cooled.



Burnham natural-gas-fired back-up boilers.

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Maintenance and Operational History

The Tecogen unit began operation in 1998 and has been running for 22-23 hours a day. Ghio reports that during the few downtimes in five years, there has been no interruption of building services. Hot water storage and grid electricity filled in for the 3- to 4-hour periods of downtime.

The DHA contracted with Aegis to maintain the CHP system at an annual cost of about \$10,000. Aegis continues to provide this service, which includes telephone-based remote monitoring of the Tecogen unit around the clock. The monitoring allows Aegis to detect disturbances and other system problems before they become noticeable to residents.

Tecogen CM-60 packaged cogeneration unit.

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COSTS AND BENEFITS

Overall, Wooster Manor reduced its annual energy expense by \$40,000, or by almost 50%. In addition to benefiting from energy cost reductions, the DHA qualified for a HUD energy consumption reduction incentive that is available to public housing authorities that obtain outside funding for their conservation project. The program allows the housing authority to keep 100% of the difference between its new, lower utility costs and the HUD subsidy that covered utility costs at the pre-conservation level of consumption. Table 1 presents a before and after comparison for the facility.

The DHA did not incur any out-of-pocket expenses for installing the system. Through Yankee Energy Financial Services, a financing affiliate of Yankee Gas, the DHA received the project capital it needed in the form of a 10-year, \$275,000 loan. The loan covered most costs, including conversion to hydronic baseboard heating. The DHA, in turn, provided the funding to Aegis, which installed the system. The DHA incurs \$10,000 per year in maintenance contract fees for monitoring the performance of the Tecogen unit and keeping the system in good operating order.

Table 1: Energy Cost and Consumption Comparison - Before and After First Year of Cogeneration Operation

	BEFORE	AFTER	SAVINGS (%)
KWh Purchased	1,254,792	206,976	84%
Electricity Cost	\$116,000	\$30,000	74%
Gas Cost	—	\$33,500	—
Total Energy Costs	\$116,000	\$63,500	45%

Wooster Manor reduced its annual energy expense by \$40,000.

End-User Perspectives

According to Ghio, the project has fully met expectations. “It will, in fact, exceed expectations if the cost of electricity rises relative to the cost of natural gas,” he says.¹ The project has performed so well that Ghio says he would not have done anything differently. Hughes agrees. “This project was a win-win for everyone involved.”

Looking to the future, Ghio believes that this project has provided an excellent model for other facilities. It is especially useful since the southwestern Connecticut region continues to anticipate electric power transmission and generation capacity shortages during peak summer demand periods.

¹ In fact, both electricity and natural gas prices have risen since 1998, but the ratio has remained relatively constant.

CHP Technologies in Multifamily Housing

CHP TECHNOLOGIES

Prime Movers. Generators which can be used in CHP systems include reciprocating engines (5 kW-7 MW); microturbines (25-500 kW); combustion turbines (500 kW-25 MW); and fuel cells (1 kW-10 MW).² Natural gas is the cleanest and most common fuel; propane is less common, but also relatively clean. There is a growing trend toward dual-fuel systems that can combust either natural gas or diesel.

Heat Recovery Units (HRUs). These units capture heat from the prime mover that then can be used for heating or to drive an absorption chiller or desiccant dehumidifier.

Absorption Chillers. Chillers transfer recovered heat from prime movers to a heat sink through an absorbent fluid and a refrigerant. The chiller cools by absorbing and then releasing water vapor into and out of a lithium bromide solution.



Small packaged CHP systems—such as the one shown here powered by a 60-kW microturbine—are being tested at DOE's CHP Integration Test Center at the University of Maryland. Packaged, or modular, CHP systems will be able to efficiently integrate into existing building energy systems.

Desiccant Dehumidifiers. Desiccants take water out of the air by exposing a desiccant material (such as silica gel, activated alumina, lithium chloride salt, and molecular sieves) to a high relative humidity air stream—allowing it to attract and retain some of the water vapor—and then to a lower relative humidity air stream, which draws the retained moisture from the desiccant.

WHY CHP FOR MULTIFAMILY HOUSING?

Market Potential. Multifamily markets hold a significant potential for CHP, where electric and thermal loads are already aggregated.

- In the HUD-assisted/FHA market, there are about 7,113 properties with 20-49 units, and 15,619 properties with more than 50 units.³
- In the public housing market, there are about 4,535 properties with 20-49 units, and 7,154 properties with more than 50 units.⁴

Low-Risk Market. Multifamily housing is a relatively safe investment. A recent report from Moody's Investors Service, a leading risk analysis firm, states, "Fundamentally, multifamily is less risky than other asset types for several reasons... There is generally less cash flow volatility, they have lower operating expense ratios, they are less capital intensive than other property types, and refinance possibilities include Fannie Mae."

Greater Control over Fuel Costs. Natural gas price volatility and high prices have given new impetus to energy managers taking advantage of peak-shaving and lowest-cost fuel purchasing.

Energy-Efficiency Gains. According to DOE, CHP systems can reach efficiencies of 80%, meaning that CHP requires less fuel than conventional systems. (In comparison, utility grid electricity is approximately 33% efficient.) According to DOE, packaged or modular CHP systems integrated into commercial or multifamily properties can offer up to a 30-40 percent improvement in building efficiency over today's best practices.

Healthier Indoor Air Quality. In combination with a desiccant dehumidifier, CHP systems can provide better humidity control than conventional systems, and reduce the potential for mold and bacteria growth.

² California Energy Commission Web site at: www.energy.ca.gov/distgen/equipment/equipment.html.

³ HUD Policy Development and Research Staff, 2001 National Housing Survey, Table 1A1.

⁴ Online query, 2002 Physical Assessment Subsystem of HUD's Real Estate Assessment Center System.

CONTACT INFORMATION

Bob Groberg, Director, Energy Division, CPD
U.S. Department of Housing and Urban Development
(202) 708-1201, Ext. 4642 • robert_groberg@hud.gov

Merrill Smith, Program Manager
U.S. Department of Energy
(202) 586-3646 • Merrill.Smith@ee.doe.gov



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